DR. BELL'S

LESSONS

ON THE

HUMAN FRAME.

DESIGNED FOR

SCHOOLS AND FAMILIES.

EMBELLISHED WITH UPWARDS OF FIFTY ENGRAVINGS.

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PREFACE.

THE thoughtlessness of childhood is proverbial; but there is reason to fear that few of any age think wisely or rightly. We live and move among the wonders of creation. We may see, every moment, and on every side, evidences of divine wisdom, power, and benevolence. The water, the earth, and the air, are full of wonders; yet few examine or even observe them.

In the following pages, an attempt has been made to exhibit some parts of the curious workmanship of the human body. For this purpose the author uses the con-

versations of a pious physician with his son; and the topics and illustrations are believed to be generally intelligible to youth attending Sunday and daily schools. The design of the volume is to impress upon the mind the great truth, that the self-existent God is the maker of all things, and that he has made them all well.

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LESSONS

ON THE

HUMAN FRAME.

CHAPTER I.

William Bell was a very good boy, and when he was quite young he tried to learn all he could about every thing he saw.

He sometimes played with other boys; but if any of them were wicked in their conduct or conversation, he avoided them, and tried to find such companions as would improve his mind and make him better. He always found that such were the pleasantest playfellows: for while bad boys were learning to lie, and swear, and steal, he and his friends were learning all they could of the works of God; and striving to make themselves useful, and to make each other happy.

He was often asking his parents, and others older than himself, about the flowers that bloomed so sweetly in the garden and the fields, and the insects that fluttered about them, and the birds that sang among the trees.

If he was permitted to go farther from home, where he could see rocks, and rivers, and forests, and mountains, he would ask about them also; and always found that the more he inquired into the works of God, the more he learned of his *wisdom*, *power* and *goodness*.

His friends were careful to answer all his questions, when they could, and to teach him that every thing was made by God. In this way he learned that he should fear to offend a Being who is so powerful, and that he should love one who is so good. Surely, all the things which we see, do show that God is powerful; for how else could he make such a vast earth, with all its wonders, and such a beautiful sky, with the sun and moon, and all the shining stars? They

also show that he is *good:* for if he is not good, do you think he would make such sweet flowers, and such delicious fruits, and such a beautiful earth for us to live and be happy in? And we are not the only beings who are happy in this pleasant world. See! how gayly the butterfly sports in the sunshine, above the smiling meadows; how eagerly the bee gathers honey from the flowers; and how cheerful the little birds are in the groves, while they are singing their songs of gratitude for the many comforts which they have. Look at the sheep and cattle, how contented they are, while they are feeding upon the grass that is so bountifully spread upon the earth for them! Are they not all happy? And is not the God that made them so, a good God?

Another thing William Bell learned from all he saw: it was that God was WISE, as well as good and powerful; for he found that every thing was made for some particular purpose, and that every thing answered the purpose for which it

was made. Must he not be *wise* to know how to make every thing so that it would do just what he wanted to have it? He made the sun to give light and heat: and it does give light and heat. If he had made *something* in place of the sun, it might have been very *great*, and have shown his *power;* and if he had wanted it to give light and heat, it would have shown his *goodness;* but if it did not give light and heat, it would not have shown his *wisdom*, for it would not have done what he intended it to do. But it does give light and heat. How well you can read, and play, and enjoy all the pleasant sights which you see by its light: and by its heat, the grass springs up, and the flowers blossom, and the fruits ripen. God is *wise* then, as well as good and powerful; else how could he make a sun which answers so well the very purpose for which it was made? The more we learn, the more we shall discover of his goodness, wisdom and power.

William's father was a very learned

man, and a physician; and he took great pains to instruct him in what was useful. But he was often from home, and William could not always ask him for the information which he wanted; so his mother answered his questions as well as she could. But still, every day, and a great many times in a day, he saw a great deal that he could not understand, and much that could not be well explained. When he asked his mother about such things, she used to tell him that they could not be explained, without more knowledge than God had permitted her to acquire. So he soon learned, that there were some things which he could not know. Then he would be content, and not ask any more questions. But he did not leave off *thinking* about any thing, because he could not understand it at first.

Dr. Bell sometimes took William with him when he was riding out to see sick people, and William was always delighted to go with him. He often wondered how

his father should know better than others what was good for the sick, and how he could set bones, and do many other things to help them when they were injured. One day he asked his father to teach him to be a doctor, that he might be useful, and relieve distress, and have people love him.

Dr. Bell said, "I am glad, my son, that you wish to do good, and relieve distress, and hope you will not omit any opportunity of doing so; but I fear you are not old enough to understand that which is necessary to learn before you can be a physician. Besides, I think you will find none who are willing to trust you to take care of them in their sickness, while you are so young."

"But, father," said William, "cannot I begin to learn, so that I may know how when I shall be a man?"

"There is a great deal," said Dr. Bell, "to learn about the human frame, and the nature of medicines, and many more things than you would suppose, before

you can begin to understand the nature of diseases, and how to cure them. You did well to inquire of me about them, for you may learn much upon these subjects which will add to your stock of knowledge, and lead you to admire more than ever the wonderful works of a good God. We shall not have time at present to talk about it more; but when we are at home, and have time, I will give you some lessons which will interest and improve you."

Dr. Bell was not only a learned man, but he was an humble Christian; and he took good care to impress on William's mind that all the wisdom, and goodness, and power which were to be seen in the works of the great Creator, were of small importance compared with what the Bible tells us of his justice and holiness, his mercy and truth; that he not only created the world in wisdom, and upholds it by the word of his power, but he so loved our sinful and ruined race, as to give his only-begotten Son, that whoso-

ever believeth in him should not perish, but have everlasting life. Thus William was taught by his pious father to regard the Scriptures as the great source of light and knowledge, and to look upon the wonders of creation as so many witnesses to the truth of what the Bible reveals. He would have his child adopt the language of one of the pious Dr. Doddridge's hymns:

Ye sons of men, with joy record
The various wonders of the Lord;
And let his power and goodness sound,
Through all your tribes, the earth around.

Let the high heavens your songs invite,
Those spacious fields of brilliant light;
Where sun, and moon, and planets roll,
And stars that glow from pole to pole.

But O! that brighter world above,
Where lives and reigns incarnate love—
God's only Son, in flesh arrayed,
For man a bleeding victim made.

Thither, my soul, with raptures soar,
There, in the land of praise, adore;
The theme demands an angel's lay,
Demands an everlasting day.

CHAPTER II.

It was not many days before William found his father at home, and apparently at leisure; so he asked him if he would not then fulfil his promise to instruct him about sick people and medicine.

Dr. Bell said, "I shall be very happy to instruct you, my son, but you must listen attentively, and not be in haste to get through; for there is a great deal to be learned upon this subject, and many things connected with it, which everybody should know for their own profit, as well as the good of others. All this cannot be taught at once. I shall therefore give you short lessons, and I wish you to attend to them patiently, with a desire to know all you can. But what do you think I shall begin with?"

William. You told me the other day that I could not know how to be a physician, without understanding about the human body. Cannot you tell me about that first? I should much like to know how I am made.

Dr. Bell. Yes. On many accounts it would be best to begin with that subject; for there is no knowledge more important than a knowledge of ourselves. True, it is the *mind*, the *soul*, that thinks, and knows how to direct the motions of the body; which does right or wrong; which enables us to love and hate, and know about God, and heaven, and all things which are made. And the soul will live when the body dies. It is therefore the soul which makes the body so important, and it is this which makes it so desirable to know how the body is made. For the body is the dwelling of the soul; and it is in this dwelling that the character of the soul is formed, and fitted to love God and enjoy his presence forever, or to hate him, and be cast away from his presence

forever. It is very important, therefore, that we learn about the body, and so regulate its actions, that when we come to leave it in the grave, we may have the joyful hope that the soul shall live and be happy. Many people only value the soul for what it enables them to enjoy in this life, and employ all its powers to feed, adorn, and gratify the body. But they are foolish and wicked; for with all its adornments and pleasures, it is made of the dust, and must return to dust again. Let us then be wise; and while we take care of the body, let us see that the soul is clothed in those robes of the Redeemer's righteousness, in which alone we can appear acceptably before God.

If you wish to learn to be a physician, it is indispensable that you should first learn about the body. How else could you know how to put the body in order when it is disordered? Do you recollect how, the other day, when the clock stopped, we could none of us put it in motion again, because we did not know how it

was made? But the clock-maker made it go directly, because he knew how it was made, and what part of it was out of order.

W. Has my body as many and as curious parts as our clock?

Dr. B. O yes, a great many more, and more curious, and more difficult to understand. Just look! there are a great many parts on the outside of the body; but not near so many as those which are inside, and which you cannot see. We will look first at those which are on the outside. Here we find that they are all different, and appear to have different uses. Your body is not rough like a rock, and round and hard like a log or barrel; but it is regular and smooth, and soft, and almost white. It has a trunk, and head, and arms, and legs, and hands, and feet, and fingers, and toes; and there is a skin over the whole of it. About the face, there are the eyes, the nose, the mouth, and the ears. These are some of the things which you see on the outside of the body; and

they are all different from each other, and have different uses. You see with your eyes, and hear with your ears, and smell with your nose, and taste and eat with your mouth; and if any thing touches any part of your skin, you feel it; so you see, your skin was made in part to feel with; your hands are made to take hold of things with, and your feet to stand and walk with. Thus you find that the parts of the body which are different, are made so because their uses are different. As we examine more particularly the other parts of the body, we shall understand why one part was made in one way, and another in another. We shall perceive, also, that all the parts were made and put together by a being who wished to have us happy, and knew how to make us so that we might be happy. This you should remember; for there is no other way of understanding why the numerous parts of our body were made and arranged as they are.

Dr. Bell was going to instruct his son

more in the subject which he had begun, but he was called away to see a little sick boy. It was one of William's classmates in the Sunday-school, and a very good boy. He had no father, and his mother was very poor; and William loved this little boy, because he was good; and he was glad to have his father go to see him, although it put an end to his lesson before he had begun to learn much about the human frame. Still, he had learned enough to reflect upon, and hoped that before long his father would have time to teach him more.

As soon as his father was gone, William went into the garden to amuse himself. He found the gardener at work, and noticed how he took hold of the spade with his hands, and pushed it into the ground with his feet, then raised the soil up and threw it down again, so as to break the clods to pieces, and make the earth loose and mellow. He observed many other of his motions, and could not but think what it was inside of the gar-

dener that made all his limbs move just as he wanted to have them; yet he saw that they did move, and remembered what his father told him, how God made our bodies so, that all the parts could do what God wanted them to do. In this way William amused himself, by observing and thinking of the things which he saw, till his father returned.

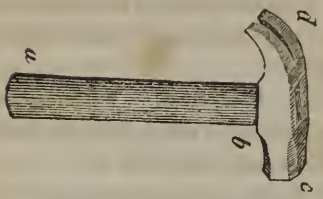
CHAPTER III.

After Dr. Bell had been to see William's class-mate, and had given him something to make him better, he came home, and began to instruct William again.

Dr. Bell. Before I went away, I asked you to remember that we were made by a being who wished us to be happy, and knew how to make us so that we might be happy. There are some foolish people who think all things came into being by themselves, without any cause. But I do not see how any thing can come into being without a cause, or something to make it. Bring me your hammer that lies on that chair.

William. Yes, father, here it is.

Dr. B. Let us look at it. This long



part is of wood, *a*, and the other part is of iron, *b*. The wood part is round and smooth, and is called the handle. The iron part on one side of the wood, *c*, is thick and heavy, and flat on the end: this is called the head, and the flat part the face. The iron on the other side of the wood, *d*, is thinner and crooked, and has a slit in it: this is called the claw. Do you think this hammer came to be so by itself, or did somebody make it?

W. I think somebody made it; because you told me that iron was made of ore, that looks like a kind of stone, and is found under ground; but this is even, and part of it is bright, and it does not look like a stone at all: and wood,

when it grows, always has bark on it and leaves, but this is very smooth, and has neither.

Dr. B. Very well. Is there no other reason why you think it could not grow in the shape in which it is?

W. Yes; the wood and iron are very nicely fitted to each other, and I never heard of wood and iron growing together.

Dr. B. You are right. It could not have grown so, or come to be so by itself. Besides, it must have been made for some use; for nobody would make such a nice thing as this, with its parts so nicely fitted, if he had not intended it for some use. Well, then, what is it good for?

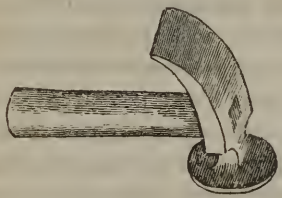
W. It is good to crack nuts, and to drive nails, and to draw nails out of boards.

Dr. B. Yes, it is very good for these purposes; for I can take hold of the wood part because it is so long and smooth, and makes a very good handle; and the head is heavy, and will crack a

nut or drive a nail very well, if I strike them with it; and if I want to draw a nail out of a board, I can take hold of the nail with the claw of the hammer, and pull back the handle, and the nail comes out very easily. Do you not think, then, that the man who made the hammer made it to crack nuts, and to drive nails, and draw them out again?

W. Yes, father; I think he made this hammer for those uses. But I saw a shoemaker use a hammer not made like this one.

Dr. Bell took his pencil and made a picture like this, and asked William if



it was not like the hammer that he saw the shoemaker use.

W. I think it is something like it.

Dr. B. You see the head of this hammer is not so straight as the head of your's; but it has what may be called a neck, and has a broad face that is very smooth and rather roundish, and the claw has no slit in it, and is not so crooked as your hammer.

W. I see now: it is *just* such a hammer as the shoemaker had.

Dr. B. Well, you saw the shoemaker use it, I suppose?

W. Yes; he hammered a piece of leather, which he put on a stone that he held in his lap.

Dr. B. That stone is called a *lap-stone*, and the leather which he put on it was for the sole of a boot or shoe. It was flat, and he wanted to make it more round. So he wet it, and hammered it with the smooth, round face of his hammer. Sometimes he wants to shape the leather differently, and then he strikes it with the claw. You see his is just such a hammer as he wants, for he wants no slit in it to draw nails.

Here is the picture of another hammer. The head is something like the head of your's, but the claw is very broad and thin, and sharp on the end. This is such

an one as is used by the cooper, and is called an *adze*. The sharp end is used to trim and fit the hoops.

There are, besides these, several kinds of hammers of different shapes, all made by somebody, for different uses; and there are good reasons why each is made as it is. Suppose a man should make a hammer with a handle of iron, and the other part of wood; how quickly the wood part would bruise if you should drive nails with it! And how soon the claw would split if you should draw nails with it! You would think a man that

should make such hammers must be very foolish.

W. But there would not be many people foolish enough to buy them.

Dr. B. No; and the man who makes hammers for sale knows better how to suit those who use hammers. He makes a joiner's hammer, like your's, with a claw and slit; and the shoemaker's hammer with a round, smooth face, and blunt claw; and the cooper's hammer with a sharp claw. Then he is able to sell them, and every-body will think he is *wise* to know how to shape them all to answer the purpose for which they were intended. Now, as you become acquainted with the different parts of the body, you cannot doubt but they are made by a being who knew how to shape them to answer the purpose for which they were made. Who do you think this being is?

W. It cannot be any but God—can it, father? —that is able to make such a wonderful thing as the human frame?

Dr. B. No, my son. Nobody but God could make and adjust all the parts of the human body. Look at your arm and your hand. Here at the shoulder is a joint, made so that you can swing your shoulder around, and reach in every direction. You can pluck a peach from the trees above your head, or gather strawberries from the vines which grow upon the ground. You can bend your arm, too, at your elbow, and put your peach in your pocket, or your strawberries in your mouth.—Look at your wrist, too. Here your hand is fixed so that you can bend it, or turn the palm up or down, as you choose. And your fingers are all long and straight; but you can bend them whenever you want to take hold of any thing. Did you never notice all this before?

W. Yes, father. But I never thought it so curious; and yet I cannot see how it is so made.

Dr. B. Well, it is very curious. Suppose God had made your arm stiff at

the shoulder. You might bend it at the elbow, but that would only enable you to bring your hand up a little way. You could not pluck a peach from the tree, and you would be obliged to sit on the ground to gather strawberries from the vines; and when you had gathered them, it would be difficult to put them to your mouth or your pocket. And if your arm could not bend at the elbow or the wrist, you would be obliged to get very near any thing which you wanted to take hold of; and then you could not take hold of it very easily. But suppose God had not made a thumb on your hand; you might take hold, but could not hold tight: and if he had made your fingers stiff, so that you could not bend them, or if he had made your hand like the horse's hoof, how could you get along in the world? What could you do?

W. I could do nothing. Somebody would have to feed me and put on my clothes.

Dr. B. Yes! But if every-body was

made so, who would be found to take care of you then? God knew better how to make an arm, and hand, and fingers, so that we could help ourselves, and was so good that he did make us so. I have shown you enough at present to convince you that the human frame was made by a wise, great, and good being, and that that being is God; and this truth is taught in every thing he has made, and is important for you and all children to remember; for if in learning about his works, you omit to learn and feel this, you might almost as well learn nothing. For no knowledge but that which teaches you to admire his character and love it will be of any use to you when you come to die.

I have now given you a longer lesson than usual, and I fear I have already detained myself too long from my business; so I will defer what I have to say further to another time.

CHAPTER IV.

In the mean time, William did not forget what his father had taught him, but was thinking of it very often when he had leisure from other duties. While at play, too, in noticing the motions of his own and his playfellows' limbs, he was more surprised than ever to see how swiftly the legs would move in running, and how various and graceful were the motions of the body in playing ball; how firmly the hand would grasp the bat; how strongly the arms would move it to strike the ball; and how gracefully and accurately the limbs and body were moved to catch and hold it. Thus he learned that the human frame was fitted to answer all the purposes of the most eager activity, in play as well as in labour. In walking in the fields, he would look at the cattle, and horses, and

sheep, and amuse himself by observing their motions while eating or at play, and noticing how different their movements were from those of men. He was quite puzzled to know why they were not made as beautiful or with as convenient limbs as the human race, and determined to inquire of his father at the first opportunity.

He thus formed the habit of observing other things also, and became very curious to learn about every thing he met with. He found that the possession of a little knowledge made him desire to obtain more.

The only way to learn a great deal is to learn by little and little. We cannot learn every thing at once. Indeed the time will never come when we shall know every thing. In this life, no man ever learned all that could be known even of the most common things around him; and in the life to come, the boundless universe of the great God, with the never-ending new creations of his power,

will forever furnish subjects for the research of the mind.

Dr. Bell had now become so much interested in teaching William, and was so desirous of instructing him, particularly in those things by which he was so often called to admire the goodness of God, that he would willingly have spent more of his time in his lessons, but could not without neglecting his patients. He came home the day after the last lesson much earlier than usual; and William did not let so good an opportunity pass without asking his father why the animals which he saw in the fields were not furnished with limbs as convenient as his?

Dr. Bell answered: "The limbs of all animals *are* as convenient for *them* as *your's* are for *you*. If cattle had been designed for the same purposes as men, they would have been like men; but then they would not have been cattle; they would have been men. This very difference between men and beasts shows the wisdom of God, and his goodness,

too; and you will be better satisfied with this the more you examine the construction of both. We will proceed now with the subject we have begun. Do you remember what was the subject of our last lesson?"

William. Yes, father. You were showing me the reason why the different parts of the body were made differently. I hope you will explain something this evening that I do not know as well about as I do about the arms and hands.

Dr. Bell. You will find, as you learn more, that you know but very little about the arms and hands. A learned man in England has written a large book about the structure of the hand; and what has been written by others on the same subject would fill a great many volumes. The arm and hand are made up of a great many parts, of different substances; and the laws which regulate them are more numerous and more curious than those of a clock, or any other machinery. I doubt very much

whether any man, if he had ever so much ingenuity, could make a machine which would perform all the motions of the hand, arm, and fingers.

W. I went with you once to see some puppets, which danced and moved their arms about; and the man who showed them to us said that he made them.

Dr. B. No doubt he did. But their motions were very few. They only danced and threw their arms out. They could not sew, or spin, or write, or play upon the piano-forte, or do many other things which can be done by the hand and arm. Yet we were all astonished that the man could accomplish so much, and his ingenuity has astonished a great part of the world. How much, then, should we admire the power and wisdom of God, who could make the hand and arm, and the other parts of the body, which are still more wonderful?

W. How many motions can I make with my hand and arm?

Dr. B. Try. You see they are so

numerous that you cannot count them. With the simple machinery of the hand and arm, you perform almost all the offices of labour and play. With them you can lift, strike, grasp, pull, twist, throw; and, indeed, there is hardly any thing which we can do without the use of our hands and arms.

W. I long to study more about them. I am ashamed that when I knew so little, I should think I knew all about the hand and arm.

Dr. B. I hope you will have opportunity. But I think you do not yet see the importance of the joints, or how utterly helpless we should be without them. Did you never notice how lame old Mr. Bradley walks when he goes by here to church?

W. Yes, father. What makes him so lame?

Dr. B. It is because his knee joint is stiff, so that he cannot bend it. This obliges him to swing his leg about a great way every time he steps; and

when he sits down, that leg sticks out while the other is bent.

W. Old Peterson, the gardener, walks just so. Why cannot they be cured?

Dr. B. I cannot explain it to you so that you can understand. But they cannot, and they are quite content to bear the inconvenience, as it is God's will. Suppose the other knee was as stiff. They would have to walk much slower, and would be very likely to fall, especially if they should attempt to sit down in a hurry. And if their hip joints were both stiff, they could not sit down at all, or get along without crutches. Mr. Hubbard has a stiff elbow, which makes it very difficult for him to hoe corn, or mow, or make hay. Thus, you see, one stiff joint is a great inconvenience; and how entirely helpless we should be if all were stiff, or, what is the same thing, if there were no joints!—

Here the lesson was interrupted by some one calling in great haste for Dr. Bell to go and see a child, who had been play-

ing with a cherry stone, and it had stuck so fast in the nose that it could not be got out without instruments. Such accidents happen very often when children are allowed to play with beads, peas, beans, or such things; and sometimes a more serious one still takes place if such things are put into the mouth: for they often slip down into the windpipe; and when they do, they either choke the child immediately, or make it necessary to perform a very dangerous operation to remove them.

When Dr. Bell returned, after having taken the cherry stone from the child's nose, it was too late for William to attend to any more instruction that evening; so the lesson was deferred to another time. In the mean while, William retired to his bed, there to consider the increasing evidence of God's wisdom, and to thank Him for his continued care of him and his friends, and for the many opportunities which he had of contemplating his character in his works.

CHAPTER V.

The next morning William was up before the sun, and thinking of what he had been learning, and trying to discover from his own motions something more of the wonderful construction of his body. It was not long before he saw his father, with his hat and cane, preparing to take a walk before breakfast. He asked leave to walk with him, and was soon by his side in fine glee, enjoying every thing about him. The dewdrops were glittering on the grass, the air was fragrant with the perfume of the opening flowers, and the birds were singing their merriest songs. The world was beautiful, and every thing was happy, and William and his father were happy, too; and all my readers, if they will rise some pleasant morning, and walk in the fields as Wil-

liam did, will learn how much God has prepared for their enjoyment while they have been refreshing themselves with sleep.

Dr. Bell reminded William that all these things were the work of the same wisdom, and power, and goodness that constructed and arranged the different parts of his body; and said he, "Do you think all these pleasant things which we see, could exist together, every morning for so long a season, without plan or design? Could they come to be so of themselves, without anybody to make them?"

William. No, father; I think not. I cannot understand how buds, and flowers, and trees, and grass, can come to be such by themselves. If they do, then I think they must have power, and wisdom, and goodness. It is easier for *me* to believe that all these beautiful things were made by God for wise and good ends, than that they should be so of themselves. How could they make themselves?

Dr. Bell. I am as much at a loss to know

as you are. But it is not difficult for me to believe that the great God can do all these things; and I do believe it, and praise him for his wonderful works; and so will every rational being, who has sense, feeling, and taste enough to take pleasure in the works of God. You have seen enough, my son, to be convinced of his greatness, and to love him for his goodness; but the longer you live, you will see more and more to confirm your belief and increase your love; for every step in knowledge will show you more of his wisdom; and his kindness is renewed every moment of your life.

W. You cannot think, father, how much more I understand about God's power, and wisdom, and goodness, since you began to teach me about the human frame.

Dr. B. And so it will continue to be as you learn more. It will be some time before we get home, and we may as well improve it in talking on that subject as any other.

At our last lesson, you saw some of the uses of the joints, and that without them the motions of the body could not be made.

W. I have been thinking that it would have been more convenient to have our limbs made so that they would bend everywhere, like an elephant's trunk. Could we not make a great many more motions then?

Dr. B. Yes; but not such useful ones as we make now: we could not stand if our legs were so made; and we could not push with our hands if our arms were so made. Besides, there are a great many motions which are necessary, that we could not perform as well as we do now. If the elephant could reason, he would see how much more we can do with our hands than he can with his trunk. He feels it; for, with all his strength, we can catch and manage him by means of those very limbs which you think have too few motions.

W. I see now it is as necessary that

our limbs should be stiff between the joints, as it is that they should bend at the joints.

Dr. B. Do you know what it is that keeps the limbs stiff between the joints?

W. I did not know until George Gay fell down last summer and hurt his arm. Then I saw it was crooked; and you said it was because the bone was broken. You made it straight, and bound on it some thin pieces of wood to keep it so until the bone grew together. In that way I learned that it was the bone which made the arm straight. Do the bones make the rest of the body keep its shape?

Dr. B. Yes; and they are a very important part of the human body in other respects; for they are the support and defence of all the rest. The bones of infants are not perfectly formed, and are quite soft, so that they may be bent. It is this chiefly which makes them so helpless. How much more helpless you would be if you had no bones at all! Without them your body could not stand, or sit,

or move, or breathe, or eat: of course, it could not live. It would be a soft, unshapen mass, and would be utterly helpless; and if any thing heavy should fall on you, it would crush you; or if you should receive a blow with a sharp instrument, it would kill you. But now, unless the blow is very hard, the bone will stop it, or turn it aside. A soldier in battle was struck on his breast by a bullet, and it came out at his back. The surgeon thought it had passed through him, and told him he must die soon. But on a thorough examination, it was found that it had struck on the bone and glanced, so as to do him but little injury. You remember, too, that when those two drunken men quarrelled the other day, and one of them struck the other with a hoe, what a bad gash it made on his head? If it had not been for the bone of his head, the hoe would have gone into the brain, and killed him. We shall see more of this by-and-by. But you perceive already that the bones are a

defence as well as support of the body. Besides, they are so arranged and so joined to each other and to other parts, that they can be made use of to perform all the motions necessary to life and happiness.

W. Are all the bones of the body alike?

Dr. B. They are composed of the same substance; but as the parts of the body are different, so the bones are of different forms. You will see at once that your head should have a differently shaped bone from your arm and back; and it has a different one. This difference in shape I cannot describe without showing them; but when we return, we will go to the office. Then I can show you all the bones put together, very much as they are in the human body. The bones put together in this manner are called a skeleton.

W. Are they the bones of a man?

Dr. B. Yes, they are. It would be very difficult to imitate them.

W. Where did you get them, father?

Dr. B. They are the bones of a man who was executed some years ago, when it was the usual practice in many of the States, as a part of the sentence, to order the body to be given to the proper persons for dissection. It is very difficult to obtain a human skeleton. Besides the respect which is very properly felt for the remains of the dead, there is a prejudice against using a human body for the purposes of science; perhaps it is because of this association with criminals. We know, however, that in ancient times it was regarded as an expression of the utmost contempt to leave a body unburied;* and to remove a body from the grave is now, in all Christian countries, treated as a high offence. We ought ever to pay a sacred regard to these sentiments and usages. They are honourable to our nature; and all the necessary purposes of science may be answered without violating them.

* 1 Sam. xvii. 44—46. Jer. viii. 2.

W. I do not see what objection *any one* can make to having his body used after death, if it can be, properly, for the benefit of the living.

Dr. B. Nor I, my son. As I just now said, there is a prejudice against it which is not to be too strongly condemned, as it has its origin in the best feelings of our nature.

W. I am glad that you have a skeleton, that I may see and learn certainly how the bones of the body are arranged, and that I may know how to set them if they are put out or broken.

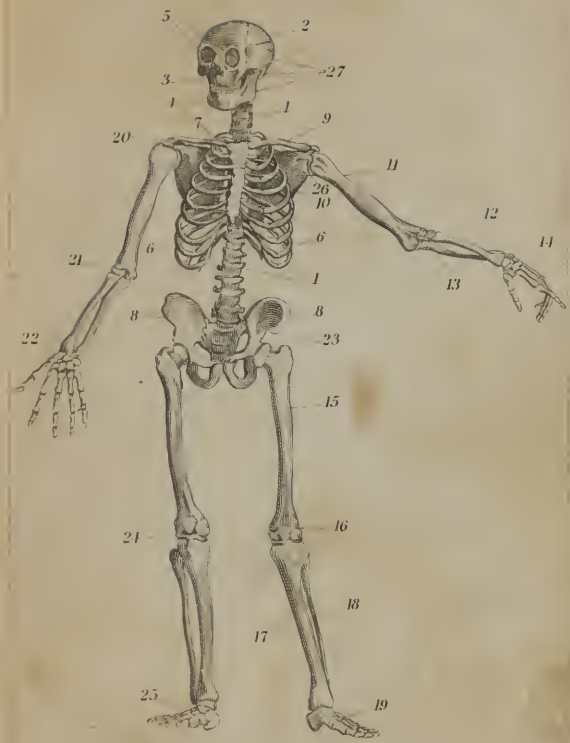
CHAPTER VI.

By this time they had reached the office, and Dr. Bell took William to a wooden case, which was generally kept locked, and opened it, and there was a skeleton at full length. William was at first rather shocked at the sight; but his zeal for learning soon overcame his repugnance, and he exclaimed with delight, "Father, see! here is the head, and here are the arms, and the legs, and the feet, and toes! How long the fingers are! and here are many bones that I do not know! Do explain them to me, father."

Dr. Bell. I will, my son, if you will be patient. But you see there are a great many bones belonging to the body, and that they are of different shapes. As you learn more about their uses, you will see that there are many good reasons why

they are shaped as they are. God does not let us know the reasons for all his works; but they are so plain in many of the bones, that we can understand them, and so well arranged for convenience and pleasure, that we cannot doubt of his wisdom and goodness.

Dr. Bell now began to point out the different parts of the skeleton, and to explain to William each bone; and when he wished to be more particular, he took from a box a bone separated from the rest, that he might show its shape. There are not many who read this book that will have the same opportunity of seeing a skeleton that William had; but the engraver has made as good a picture of a skeleton as he could, and of the other parts of the body which Dr. Bell described to William; so that my readers may, if they will, learn nearly as much as William did. Here is the picture of Dr. Bell's skeleton. It is marked *Plate I.* on the top. There are a great many figures about the picture, and from each figure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there is a dotted line to the different parts of the picture, so that you may know what part of the body William and his father were talking about. Now, when I am telling you what Dr. Bell is describing to William, I will write the number that is opposite the part which he points out. If I am telling you what he says about the wrist, I will write *Pl. I.*, No. 22, so that you can have no difficulty, by looking on the picture, to know what I am writing about.

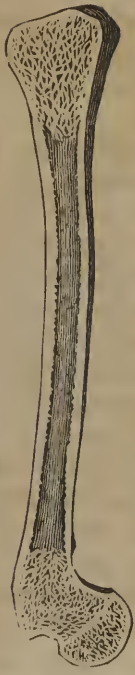
Dr. Bell. I told you, some time ago, that the bones were all made of the same substance, but of different forms. They are likewise of different consistence, some of them being more solid than the rest: they are all of them hard, and of a dull, white colour. They are most of them very strong, too; and it is necessary that they should be so, to sustain the weight of the body, and other weights which men are obliged to carry, in pursuing the various occupations of life. Besides, there is often a great strain on the bones,

produced by the motions of the body. The bones are light, as well as strong; and they should be, or we could not move so actively about. God has shown his wonderful skill, by the mode in which he has effected this design. Look at the thigh bone, (*Pl. I.* No. 15;) and here it is by itself, separated from the other bones of the body. It is quite small, compared to the strength which we should suppose it would be necessary for it to possess. If you will take it in your hand, you will not find it as heavy as you suppose, although it is so very strong.

William. How light it is! I should think it was hollow.

Dr. B. It is partly hollow. You observe the two ends are larger than the middle, and the middle is harder and more compact than the ends. But the middle has a larger hollow in it, which, in the living body, is filled with fat, or *marrow*, as it is called. This is much lighter than the bone. The two ends appear like a sponge inside, with a great

Thigh Bone.



Inside of Thigh Bone.

many little cells, which are partly filled with marrow. Here is a picture of it, sawed through the middle from one end

to the other, and it shows the appearance of the inside. In the middle is a large hollow filled with marrow, and, at the ends, something like a sponge filled with cells. If this bone was all solid and hard, and as large as it is now, it would be much heavier than it is; and if the other bones were solid and hard, it would be much more difficult for the other parts to move them. If there was no more bony matter than there now is, and if what there is was solid instead of being hollow, the bone would be small and weak, and they would bear so small a proportion to the rest of the body, that they would be very liable to break.

W. Well; but if the middle of the bone was made larger and spongy, as it is at the ends, would it not answer then?

Dr. B. No; because the shape of the limbs would be changed. The middle of each, which is now filled up with flesh, would be filled up with bone, and the flesh would be pressed out on all sides, and the limbs would look as if they were

badly swollen. The bones do sometimes become diseased, and grow large in the middle, and this produces a great deformity and clumsiness.

W. But I see no reason why it would not answer as well to have both ends small, like the middle.

Dr. B. There are several. I will tell you one, which you will understand. You know each end joins with other bones; and if they were as small where they join as you suppose, the joint would be very weak. Do you not see that it would?

W. I see it must be stronger when made as it is. And I see another reason why it would not answer: the shape of the limb would be the same as if the middle of the bones was made large like the ends.

Dr. B. It would be so. Thus you see God was wise to make the bones just as they are, that they might answer the purpose for which they were designed. I cannot now point out to you the pecu-

liarities of all the bones; but as we come to examine them separately, you will see them; and I will, as far as I am able, give you some of the reasons for their peculiar form.

W. What bone will you tell me about first? Is this (*Pl. I.* No. 1.) what is called the back-bone?

Dr. B. Yes, it is.

W. It is all in pieces. Why did you cut it up so?

Dr. B. It is not cut, my son. You see it here composed of many small bones, as it is in the living body; but they are not loose in the body as they are here, but joined together so as to form one of its most curious parts. As you have pointed it out to me, and as it is so very important, I will explain it to you first. It is this part which connects the trunk with the head and limbs, and is called the back-bone, or, more properly, the spine. It is composed of twenty-four small bones, and extends from the head to the lower part of the body. These

small bones are called the VERTEBRÆ. They are small where they join the head, and grow larger as they go down. They are so joined with other bones in the skeleton, that I cannot show them to you to advantage. So I shall show them to you by themselves. [Dr. Bell then took a whole spine, and separated it into three parts. On the next page will be seen a picture of them thus separated.] The seven uppermost of them (*a*) belong to the neck. The next twelve (*b*) have the ribs fastened to them, and belong to the back. The other five (*c*) belong to the loins. All these vertebræ are in many particulars alike. I will mention to you some points in which they are alike. First, they all have a large hole through them, near their back part. The wire on which they are strung runs through this hole. In the living body, the spinal marrow, as it is called, passes through these openings. Each of these vertebræ has a part or projection which stands out from the back part and slants downwards. And all but


a
b
c

the uppermost bone of the back have a thick piece of bone on the fore part, which is called the body. They all have projections on each side of the great hole, and there is a small hole through each of these projections. I will soon explain to you more fully the different sets of bones, and their different uses.

CHAPTER VII.

Dr. Bell and William were called from their lesson to breakfast, and afterwards Dr. Bell could not spare any more time with him for several days. At length, however, he had leisure, and began his lesson by explaining the two uppermost bones of the spine. He took them up, and said, "Here are the two uppermost bones of the spine. This one is quite the uppermost. [Here is a picture which shows the upper side of it.]

It is quite different from all the rest. The skull, or head bone, rests upon the upper part of it; and the places where they join are so small, as to seem hardly suf-

ficient to bear the weight of the head. But by the peculiar arrangement of the other bones and soft parts about it, it proves to be quite sufficient. It is an irregular bony ring, and has no body, as all the rest of the vertebræ have. There are two slight oblong hollows (marked *a*) on the upper side, near the fore part of the bone, which are covered with smooth cartilage, or gristle."

William. Father, what is cartilage?

Dr. Bell. As I am obliged to use this word often in the description of the bones, I believe now is the proper time to describe it to you. There is on the ends of all the bones which form joints with other bones, a covering of a white, smooth, and elastic substance. This is called cartilage, or gristle. Its use is to form a suitable surface for a joint. If it were not so, we could not move a joint without grating. But with this contrivance of God's wisdom, you see how smoothly all the bones move upon each other.

W. I saw a piece of a leg of veal that was boiled, the other day, with something white, and smooth, and shining, peeled off the end of the bone, and left the bone brown and rough. Was that cartilage?

Dr. B. I presume, from your description, that it was. I am glad you are so observing as to notice such things. Most people think such common incidents are of no importance; but very many of the most important truths of science are learned by observing common events. Sir Isaac Newton discovered the principle which keeps the heavenly bodies in their orbits, by observing the fall of an apple; and the inventor of the steam engine was led to his invention by noticing the steam from the lid of a tea-kettle. The great principles of philosophy are exhibited as well in the most common events around us, as in the motion of the sun, moon, and stars. Why should they not be? The same God who rolls those majestic orbs through the fields of space,

regards the falling of the sparrow, clothes the lily of the field with beauty, and numbers even the hairs of our heads. There is not a particle of creation which is not governed by his laws, as truly as the stupendous wonders of the firmament. While, then, you observe these things to inform your mind and increase your stock of knowledge, you cannot too often contemplate that Being, whose wonderful power, and goodness, and wisdom, are seen in all the works of his hands.

I do not know that I can give you a better idea of *cartilage* than you have; but I will tell you about another substance, which covers all the bones, where they are not joined to other bones. The bones of the skeleton are, as you see, dry and naked; but, in the living body, they are covered by a thin substance like the skin, which adheres very closely to them. By examining them carefully, you will discover very small holes, like points, thickly scattered over them.

W. I see them. What are they?

Dr. B. They are in part to attach the covering, and partly for the passage of small vessels which furnish them with blood.

W. Do the bones have blood? They look so hard and dry, that I should not suppose there was any blood in them.

Dr. B. They require blood as well as the rest of the body.

W. What is the use of the blood, father?

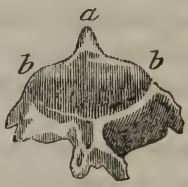
Dr. B. It would take me a great while to answer that question so that you would understand it. It is enough for the present that you know that the bones are supplied with blood. We will now return to the examination of the uppermost bone of the spine. I told you that near the fore part of this bone, and on each side of it, there were two slight, oblong cavities, which were covered with cartilage. These cavities are designed to receive two projections of the *skull*, or bone of the head, and with them form a joint. This joint admits of a slight motion in

bending the head forward, but not in turning it round. On the inside of the ring, on the fore part of it, there is a small spot (marked *b*, cut page 62) covered with cartilage, for the purpose of forming a joint with a singular projection of the second bone of the neck.

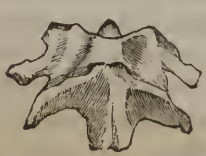
W. Will you show me that bone, so that I can understand it?

Dr. B. I will directly; but I wish you to remember the description of this, that you may understand when you come to see the other. Besides the places I have shown you, you see two small holes (marked *c*) on each side of the bone. On the under side of this bone there are two projections, which have a smooth surface covered with cartilage, for the purpose of forming a joint with the second bone of the neck. The second bone of the neck has a thicker ring, and something like a body on the fore part of it, but different from the body of the other vertebræ. On the fore part of it there is that singular projection (*a*) which I told you assisted

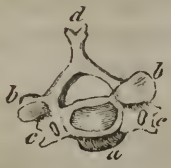
in joining this bone to the first bone of the neck. On this projection the first bone moves as on a pivot, thus enabling you to turn your head to one side and the other. [Here is a picture of the upper part of



the second bone of the neck.] On each side of this projection there is an oblong, smooth surface, (*b b*,) which is covered with cartilage, for the purpose of forming a joint with the bone above it. If you will put these bones together, you will see that they are so joined as to allow of considerable motion in bowing, and in turning the head. [Here they are thus



put together; the first picture represents them as they appear in front, and the second shows them as they appear behind.] I have been thus particular in describing these two bones, not only because they are different from any other of the bones of the spine, but because they exhibit very strongly the design of the Creator. He designed to have the head so that it might bend forward, or be moved to either side, with ease and rapidity. And what arrangement could more perfectly effect these objects? Yet, the other five bones of the neck are so arranged as to very much assist these motions. They do not naturally differ from each other in form, and this is a



very good representation of them all. Here is the body, (*a*,) the thick, roundish

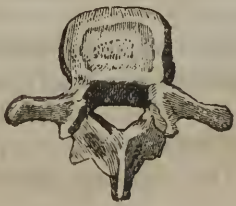
part on the front of the bone. Directly behind it, there is the large hole, corresponding with the one above it. On the upper part of the bone, on each side of the body, at *b*, there is a projection which slants upwards and backwards; and, on the under part, there are two in the same situation which slant downwards and forward, and the surfaces of the whole are covered with cartilage, for the purpose of forming joints with the bone above and below. These may be called the *oblique projections.* There are two side projections, (*c*,) one on each side of the body, and a small hole passes through each of them. These may be called *lateral projections.* There is likewise a projection from the back part of the large opening, (*d*,) which may be called the *spinous* projection.

W. Do all the bones of the spine have so many projections?

Dr. B. Yes; and they are all necessary either to form the joints, or to afford the means of binding the bones together.

The twelve bones belonging to the back or chest, have, beside all these projections and holes, two small cavities on each side, for the purpose of forming a joint with the ribs. These bones differ likewise from those of the neck, in having their bodies larger, and, in some respects, of different shape, or all their projections longer, as you see here. The five bones of

the loins are still larger than those of the back, and their projections still longer, as you see here. Besides the peculiari-



ties named above, there are some others which afford strong evidence of design. I will point out one of them to you. On the upper part of each of the vertebræ there is a small notch, which corresponds with a like notch on the under side of each, so that when the bones are put together, these notches are opposite to each other, and form holes which pass directly into the large hole of the bones.

W. What is the use of these holes?

Dr. B. They are for the passage of some important parts, which I cannot describe to you at present. I have been thus particular in the description of this part, because I thought it important, and because it was necessary to your understanding some of the motions of the body. Can you tell me what motions the spine has?

W. It moves when we bend the body forward, and when we bend it backward, and when we bend to either side. Has it any other motions?

Dr. B. Yes; it has one more very im-

portant motion, and one which could not be effected without the peculiar arrangement and connexion of the bones of the spine. I mean the motion which is made in turning the body about. Come, let us try its motions. Make a bow so as to bend your body forwards as far as you can.

W. See here! If I bend forward farther, my back will not bend any more.

Dr. B. That is enough. Now, can you tell me in what part your back bends?

W. No, father. It seemed to bend some in every part.

Dr. B. It did. Now bend on one side as far as you can.

W. Look! I can reach my ankle with my hand.

Dr. B. Can you tell me what joint bent that time?

W. It seems as if it bent everywhere, just as it did before.

Dr. B. Now see if you can bend backwards.

W. I cannot bend back so far, because I am afraid of falling over.

Dr. B. Ah! you bend enough to know that the back bends all along its course, and not at any one point. Now stand firmly on your feet, and turn your head and body, so as to look behind you.

W. That's as far as I can turn without moving my feet.

Dr. B. That is enough. Where did your back bone turn?

W. I should not think it turned in any particular place, but that it twisted like a rope.

Dr. B. You are right, my son.

W. I do not see how all these motions can be made, with the bones so locked together as they are in the skeleton. I should be afraid they would separate if they should be moved very much, either in bending or twisting, unless they were bound together very close; and if they were, I should not think they would move at all, especially in the loins, where the projections are so large and long.

Dr. B. If there was nothing but what you see in the skeleton to prevent it, your opinion would be correct; but I am now

prepared to tell you about the most wonderful part of the spine. Here is another

spine, which I wish you to look at, and see if you perceive any difference between it and the other you have seen.

W. O, yes! I see something between the vertebræ, which holds them together. What is it?

Dr. B. It is a sort of cement. In the living body, there is a thick piece of cartilage between the vertebræ, which is very firm and strong, and still elastic like India rubber. It is so yielding as to allow the bones to be moved as much as is necessary, and still so strong as to prevent them from coming apart more than is desirable for necessary motion. I have told you all I design to do about the spine at present. We will therefore not make our lesson longer now. At the next I will describe to you some other part. But you may reflect on what you know about the spine for a great while with profit, and the more you reflect, the more you will find reason to admire the wisdom of God in its construction. Do you think so many bones, with so many

holes, projections, and notches in each, which correspond so perfectly with so many holes, projections, and notches in all the others, and with so many joints between them, and so many separate pieces of cartilage of exact shape and size, so as to accommodate all the motions which the spine performs—could come into existence by themselves, without anybody to create them? Or could they be created without design?

W. I cannot see how it could be. If I knew nothing about any of the works of God but the human spine, I should believe that it was made by some wise, good, and great being.

Dr. B. I cannot believe that any one who would honestly judge from evidence rather than prejudice, would think it was a work of chance. And if it is the work of *any* intelligent cause, who is so wise to design, and so able to execute, all the wonders around us, as the Almighty God revealed to us in the Bible?

CHAPTER VIII.

It so happened, that the very next evening Dr. Bell had leisure to spend an hour with William, in teaching him further about the bones.

Dr. Bell. The last lesson was about the spine; I will tell you this evening about the bones of the head and face. Here they are in the skeleton (*Pl. I*, No. 27.) as they are connected with the bones of the neck. But here you see them better

by themselves. The bones of the ear, which are very small, and the lower jaw (*a*) have movable joints. But all the rest of the bones of the head and face are united together so firmly, that they cannot move one upon the other, nor can they be separated without force. The joints by which they are connected are called SUTURES, or *seams*. You can see them on the skull very plainly.

William. What is the use of joints which do not move? Was it not just as well to have all the skull made of one entire bone, without any joints?

Dr. B. You know the brain is in the head?

W. Yes. Are you going to tell me its use?

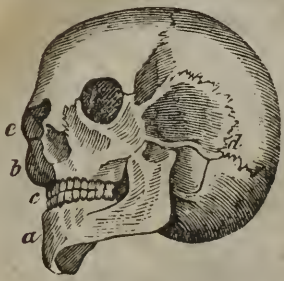
Dr. B. Not yet. I want you to understand that it is a very important organ, for the sake of showing you why the skull was made of different bones. In very young children, the bones of the head and face are not united at all, but left separate, that the brain may have

room to grow in every direction, and not be hindered by the bones. It would be hindered very much, if the bones were all made hard, and united firmly at first. But as it is, the brain can grow and the bones increase from the centre, until such an age that the growth of the brain becomes slower. Then the bones begin to unite in *sutures*, or *seams*. These seams are at first more regular, and not so firm as they afterwards become; but the bones continue to grow, until their edges come in contact, or interlock with each other in those singular seams which you find on the skull of a grown person. When the brain has attained its full size, these seams become firm; and, in old age, they are sometimes nearly invisible.

W. I think this is as curious as any thing I have seen.

Dr. B. It is curious, indeed; but there are so many instances in the human frame where the designs of Almighty wisdom are surprisingly manifest, that we think each, as we discover it, to be more won-

derful than any other. But, as I have answered your question, I will go on with a description of the bones of the head. The under jaw is in its place now, but I will take it away soon.



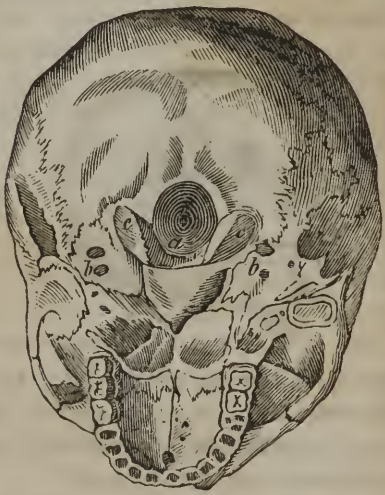
W. How like my head it is! I can guess what some of the places are for. Are not these two holes (*e*) for the eyes? And is not this (*b*) for the nose?

Dr. B. Yes.

W. And this (*c*) must be for the mouth, for here are the teeth. Are these small holes low down in the side (*d*) for the ear?

Dr. B. Yes; and the construction of the

ear is very curious, and I will endeavour to describe it to you by-and-by. Let us take away the lower jaw, and turn the



head over. You see the top, and sides and back part of it, are smooth and roundish; but on the under part it is full of projections and hollows.

W. What are they all for?

Dr. B. There is a large round hole (*a*) which passes into the cavity of the head; and there are two small ones (*b b*) just before and on the side of it, which likewise pass into the same cavity. These small holes make a passage through the bones almost as crooked as the letter S.

W. O! what a great hollow there is inside of the head.

Dr. B. Did you not expect to find such a hollow?

W. I thought there was some place for the brain, but did not know it was so large. Why! it is all hollow but a small part, which is made up of the bones of the face; is it not?

Dr. B. It is.

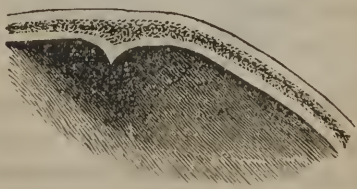
W. And is all that hollow filled with brain?

Dr. B. It is filled with the brain, and the vessels and the covering of the brain.

W. I did not know that the brain was so large. Tell me about it, father?

Dr. B. It would be out of place to tell you much about the brain now. I will

tell you, however, that it is the most important part of the body. Most learned men suppose that the mind thinks and calculates and plans by means of the brain; and they are, probably, right. It is certain that all the feeling and motion of the body depend upon the brain. Although it is so important an organ, it is very tender and delicate, and would be very easily injured if it was not wonderfully protected. How wonderfully it is protected! Nothing but great force can break through the bone which is made for its defence. You can see how thick the bone of the head is, by this



piece, which is sawed out of the skull. Besides, its round and arched shape very

much increases its strength. Indeed, no other shape would be so strong.*

* A boy, five years old, a son of Mr. Marston, a farmer on Long Island, in the harbour of Boston, fell accidentally in following his father by the side of an ox team, with his head exactly in the rut of the cart, forward of the wheel. Before Mr. Marston could possibly snatch the child from the impending danger, a heavy hay-cart wheel, having a thick, broad iron tire, rolled directly over his child's head—rising up over the space between the crown and the ear, and coming down to the ground again from the temple. The agonized father ran with the supposed mutilated, if not dead, body to the house. On examination by the mother, the scalp was found to be cut by the edge of the tire, as though a knife had been drawn over it, showing the white bone below; yet little or no blood flowed. As no injury of the skull could be detected, she closed the external wound with a simple dressing, which kept the edges together. The boy exhibited considerable confusion, but it could hardly be called a delirium, and he occasionally vomited blood for about a week. He also bled at the mouth and nose. At the end of six days the little fellow was quite restored, and we rarely see a finer specimen of juvenile health and happiness, than in this hard-headed boy. A wheel of half the weight, rolled over a dry skull, would have ground it to powder. To the admirable carpentry of the bones of the head, presenting inimitable strength in every direction, together with the

W. Shall you not tell me more about the head?

Dr. B. If it was my intention to give you, at this time, a perfect knowledge of the human frame, I might spend a great while in teaching you the wonders connected with the skull and brain. But as it is my design only to exhibit some of those where Almighty power and wisdom are most plainly seen, I shall soon go on to describe the other parts. You noticed, some time ago, the hole for the eyes, and ears, and nose. Did you see the smaller passages which led from them to the hollow of the skull?

W. I did not; but now I see those which pass from the sockets of the eyes. Are there such from the nose and ears?

Dr. B. Not so large; but they all communicate with that hollow. You cannot trace the passages without separating or breaking the bones of the face and skull.

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resistance of the living principle, vitality, which is only known by its name, are we to look for the preservation of this child.—*Boston Medical and Surgical Journal.*

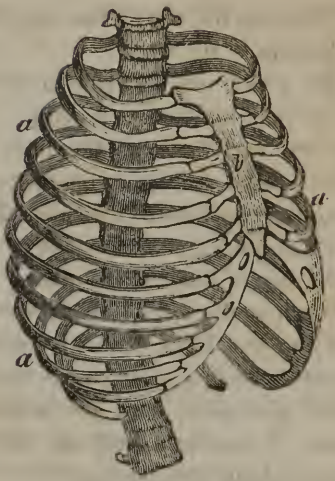
W. What is the use of that large hole in the bottom of the skull?

Dr. B. I did not describe it to you very fully; let us look at it again. You observe on each side of the hole, and close to it, two smooth projections (*c c*) which are covered with cartilage. These are for the purpose of forming a joint with the upper bone of the neck. You see this brings the large hole in the skull opposite to the large hole in the bone of the neck, in this way connecting the cavity of the spine with the hollow in the head. I believe I shall not tell you any more about the bones of the skull at present.

W. What shall you describe next?

Dr. B. The part of the frame next in importance is the chest. [See cut on page 88.] It is composed partly of the ribs partly of the breast bone, and partly of the spine.

W. The ribs are those long, crooked bones (*a a*) which look something like hoops; are they not?



Dr. B. Yes. And the breast-bone is that flat bone (*b*) which you see on the fore part of the chest, to which the ribs are fastened. Here it is by itself. [See cut on page 89.] It is divided into three parts in childhood, and the lower part (*a*) is cartilage until old age, when it sometimes becomes bone; then they are united in one. You see that part of the ribs which joins the bone is very unlike the rest.

W. I do. That is not bone; is it?

Dr. B. No. It is cartilage. The other end of the bone is joined to the spine.

W. What is the use of such long pieces of cartilage?

Dr. B. In the living body they are soft, and easily bent, and elastic; so that if the body should fall, or a weight fall on it, or the chest should receive a violent blow, the ribs might not be broken.

W. I thought Mr. Jones broke his ribs when he fell from his horse last winter.

Dr. B. He did. But his fall was very

severe, and his side struck upon the corner of a stone. If it were not for the limber cartilages on the end of them, almost any slight fall would break the ribs; but, as it is, they bend instead of breaking.

W. Why would it not do to have all the ribs of cartilage?

Dr. B. They would bend too much; and the parts within the chest would be often hurt by pressure on the outside. But now they are defended by bone, which resists injury, and, at the same time, has enough motion for all necessary purposes.

W. What is in the chest which needs defending?

Dr. B. The heart, the lungs, and some of the most important blood vessels. These are often saved from wounds by means of the ribs. I told you, the other day, of a soldier whose life was saved by his ribs. I have known a great many other instances, where the ribs prevented dangerous instruments from entering into the chest.

W. Would a wound in the vessels contained in the chest kill a man?

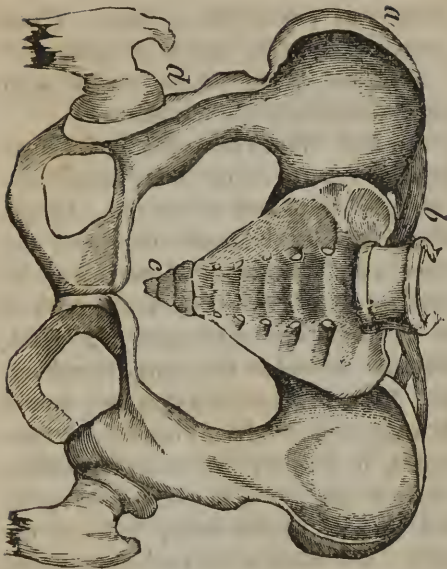
Dr. B. Always, if made on the heart or large blood vessels. But, as I have shown you, they are defended by the ribs, the breast-bone, and the back-bone. Do you think such a benevolent arrangement could happen from chance?

W. I should think not; and it shows goodness, too.

Dr. B. You are right. Thus you see again, and you will at every step you take in acquiring knowledge, the same wisdom, power, and goodness in all the works of God.

CHAPTER IX.

The next evening Dr. Bell was ready to instruct William again, and William was ready and waiting to attend to his instructions. "We talked about the chest at the last lesson," said he, "this evening I will describe to you the lower part of the trunk. You see here (*Pl. I*, No. 1.) a part of the spine. It is called its lumbar portion. Immediately below it, and connected with it, are some irregular bones, which form a cavity in appearance something like a *basin*. This basin is called the *pelvis*. It consists of eight bones in children, and they are described separately by most anatomists. But I shall describe them as four. [Here is a picture of the pelvis, with part of the thigh bones attached.] The two large spreading bones (*a*) which form the sides



of the pelvis are called the *share bones*. They are joined together, in front and behind, to another bone (*b*) called the *sacrum*. The spine rests upon this bone, and is supported by it. The fourth bone of the pelvis, which I shall mention, is the *os coxygis*. It is attached to the

lower part (*c*) of the sacrum. These bones are joined by means of cartilage."

William. What is the use of such large, strong bones in the pelvis?

Dr. Bell. There are some of the most important parts of the body placed between the chest and the pelvis. Among which are the stomach, the liver, the bowels, &c. These could not safely be confined in a bony cavity, on account of the frequency and suddenness with which they are distended in eating, breathing, &c. Still, it is necessary that they should be supported firmly. They *are* so supported, in part, by the strong, spreading bones of the pelvis, in part by the spine, and in part by the fleshy walls of the belly. The bones of the pelvis are strong, not only for the support of these organs, but for the purpose of sustaining the whole body, and all the weight which the body carries. The thigh bones, as you see, (see page 93,) are inserted in the under part of the pelvis. The large round head of each of these bones is in-

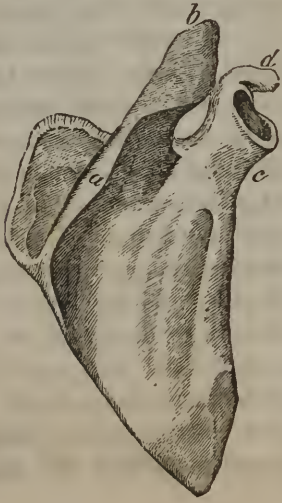
serted into a deep socket (*d*) in each share-bone of the pelvis. Although I have not, nor can I now, show you all the curious arrangements for wise purposes, which might be shown about the pelvis, you still see enough in the shape and strength of the bones, to increase your wonder and admiration of the great wisdom and benevolence of their Creator.

W. But the arms are not attached directly to the trunk, as the legs are.

Dr. B. No. And it will be necessary that I should describe several bones before you can see how the arms are connected to the chest. You see here (*Pl. I*, No. 9.) the collar-bone joined to the upper part of the breast-bone, (No. 7.) The other end is joined to the shoulder-blade, and the arm bone is joined to the shoulder-blade, (No. 20.) So the arm is not attached directly to the chest, but to the shoulder-blade, and that to the collar-bone, and in this manner to the breast-bone. The collar-bone is a long, round bone, shaped something like the Italic

letter *f*. [Here is a picture of it.] The

shoulder-blade (*Pl. I*, No. 10.) is a large, thin, three-cornered bone, with a ridge along on the back of it. Here it is by



itself. This ridge (*a*) runs the whole length of the bone, and extends before it at the forward corner, (*b*,) and forms a strong projection. Almost directly below it there is another projection, (*c*,) which contains the hollow, or socket, in which the head of the arm bone moves. On the upper and fore part of this (*d*) there is another strong projection. One of these is to form a joint, and the other two, in part, to defend it.

W. What other use have these two projections but to defend the joint?

Dr. B. They are for the attachment of other parts, and I shall speak of them again when I describe those parts. The arm bone is a long, round bone, nearly straight. Here it is on the skeleton; (*Pl. I*, No. 11.) and here you see it by itself. (See p. 98.) The upper end of this bone (*a*) has a round, smooth head, covered with cartilage, which is fitted to the cavity in the projection of the shoulder blade. At the lower end (*b*) there is a smooth surface, covered with cartilage,

to make part of the elbow joints. The bones below the elbow, and which join the arm bone, are the bones of the fore-

arm, one of which is called the radius, (*Pl. I*, No. 12.) or spoke bone, because it is shaped like the spoke of a wheel. The other is called the ulna, (*Pl. I*, No. 13.) or ell bone, because it was used as the measure of an ell. These two bones form a joint with the arm bone, and with

No. 1. *No.* 2.

the bones of the wrist, and with each other. It is by means of their connexion with each other that the fore-arm has the twisting motion by which the palm of the hand is turned up and down. You see them here (No. 1) as they are when the arm hangs naturally by the side; and here (No 2) as they are when the hand is turned with the palm forward.

W. How few are the motions I could make with my hands if these bones were put together without the power of moving!

Dr. B. There is another provision of God's benevolent wisdom in the construction of the ulna, where it joins the arm bone, and of the arm bone at the same joint. I had almost forgotten it in my haste. You will see on the arm bone, if you will look at it again, on the back part of it near the elbow joint, a deep pit or hollow, (*c*,) and on the upper end of the ulna there is found a long projection whose forward surface is smooth, but shaped something like the letter C. By putting these bones together, you will

see that the hollow part of the projection moves over the end of the arm bone, and fits into the deep hollow on the back part of it.

W. What is the use of this, father?

Dr. B. I can explain it better when I come to speak of the parts which are connected with the projection. I will now show you the bones of the hand, and here they are.

W. I have been wondering why there were so many bones in the wrist. There are seven or eight little irregular bones

crowded all together. Why might they not as well have been one large bone?

Dr. B. They are many and small for the purpose of accommodating the motions of the hand. If they were one solid bone, the motions of your hand and fingers would not be as free as they are now. There are eight of these bones, and they are so shaped as to be fitted to each other, and to the bones of the forearm, in the most curious manner. But it would take too long for me to show you all the remarkable peculiarities of their form. There are joined to these small bones five small and long bones. Four of these (*a*) join with the fingers, and one (*b*) with the thumb. The finger bones (*d*) join these at the knuckles, and they need no description, for you can see how they join by looking at them here, and understand their motions by moving your own fingers. Thus you have some knowledge of all the bones of the body except those of the leg and foot. We shall have time just to look at them at

this lesson. The thigh bone you have seen, and I will point out to you some of its peculiarities. In shape it is something like the arm bone, but larger. The head is more like a ball than the head of the arm. There is likewise a considerable neck between the head and the body of the bone. The head is smooth,

and covered with cartilage, and is fitted to move in the deep hollow on the outside and lower part of the pelvis. The lower end of the bone is likewise covered with cartilage, for the purpose of forming a joint with the bones of the leg. The bones of the leg (see p. 103) are two; the shin bone (*a*) and the splint bone (*b*.) The shin bone, as you see, is a large, three-cornered bone. It is joined to the thigh bone by a very large surface covered with cartilage. The splint bone is joined to the foot and shin bone in such a manner as to give to the leg the twisting motion necessary to turn the foot outward. There is a curious little bone (*Pl. I*, No. 16.) placed directly before the knee joint, and attached to the top of the shin bone by ligaments. I shall allude to it again, for the purpose of showing its use. Here it is. It is the *patella*, or knee-pan.

W. There are more small bones in the ankle than there are in the wrist, and more uneven.

Dr. B. These bones which unite to form the heel and instep, although they are very irregular, are put together in such a manner as to form an elastic arch, which prevents the body from receiving too severe shocks in jumping, running, leaping, &c. This is another instance in which God effects his kind purposes towards his creatures, and impresses us with renewed evidence of his goodness and wisdom, and the fullest confidence

that he who has wrought such wonders for the temporal convenience of his undeserving creatures, will not withhold any good thing from those who love and obey him.

CHAPTER X.

At the next lesson William told his father that he saw the bones were all very well contrived to form joints with each other, but he did not see what holds them together, or what makes them move.

Dr. Bell. In the skeleton they are fastened together with wires, as you see; but in the living body there is a different arrangement for keeping them in place. I will give you some account of the different kinds of joints. The first kind which I shall mention is that where bone is united to bone, without any substance between them.

William. Are not the sutures of this kind?

Dr. B. Yes; they are. The next kind is where the bones are connected together

by means of cartilage. Do you recollect what are joined in this way?

W. Yes, father. The bones of the spine are joined by cartilage; and, I believe, the ribs are joined to the breast-bone in this way.

Dr. B. They are. I am glad you remember so well what you have been taught. Now, all the bones which move upon each other, well provided as they are with the means of making good joints, would be useless, unless they were kept together at the joints. You see they can be easily put together, so as to show the manner in which they move upon each other. If there was no mode by which they could be held so while all their motions were performed, they would be imperfect. But there is a mode by which this is accomplished, and one which we could expect only from infinite wisdom. You will notice that all the bones near their ends are rough and ridgy.

W. I do.

Dr. B. There is a substance something

like the covering of the bone, but a great deal thicker and stronger, that is attached firmly to this rough surface of the bones, near the end of each of the two which are to form the joints, and binds them both together, so that their joining surfaces move upon each other freely, while the joint is made very strong. This substance is called LIGAMENT, and is used to bind all the movable joints. Where the joint has much motion, as at the shoulder, the ligament is large and loose. Where there is little motion, as at the place where the ribs join the back, the ligament is firm and short. So it affords the best means of holding together all the joints which have any motion, strongly, and yet so loosely as to accommodate all the motions of the body and limbs.

W. The motions of the joints, I see, are not alike.

Dr. B. They are not. Some require very little motion, like that between the shoulder-blade and collar-bone; some

have a hinge-like motion, like the knee and fingers; others have the ball and socket motion, like the shoulder and hips.

W. I now see what keeps the bones in their places, but do not know what makes them move. Will you tell me, father?

Dr. B. They are moved by instruments called muscles. I cannot show you the real muscles as I did the bones, but there are very good pictures of them which I will show you. But first come here, and I will tell you how you can feel them move. Press your finger hard upon your temple above and a little forward of your ear, and bite as if you were cracking a nut with your teeth. Now stop biting. Do you not feel something move up when you bite, and down when you stop biting?

W. Yes; I do.

Dr. B. That is one of the muscles which moves your under jaw when you eat. Now place your finger just before and below your ear, and shut your mouth

close. Do you not feel something move?

W. Yes. It moves just as the other does.

Dr. B. Well, it should; for it is a muscle that helps the other to move the jaw-bone. There are a great many muscles in the body, and no part of it can move without them. They form a great part of the flesh of the body. They are mostly red in men, and make up all that part of the meat of animals which we call lean. They are composed of fibres closely bundled together. You see them lengthwise when meat is cut "with the grain," as it is called; and when it is cut "across the grain," you see their ends cut off. These muscles, which seem in the animal or in man to be an irregular mass, are all made for distinct purposes, and each is arranged to answer the purpose for which it was made. They are generally described as having three parts, the head or origin, the belly, and the insertion. The head

is that part which is attached to a fixed portion of the body; the belly is that portion which contracts, and the insertion is that which is fixed to the part to be moved. Here is a picture of one of the muscles of the arm. Its head (*a*) is fixed

to the shortest of those two projections of the shoulder-blade, which I told you were in part to protect the shoulder joint. The belly (*b*) lies along on the forepart of the arm; and its insertion (*c*) into the arm about halfway from the shoulder and the elbow, and it is used to move

the arm forward and upward. Muscles sometimes have more than one head, like this picture, which represents another muscle of the shoulder and fore-arm.

The origin and insertion of muscles are sometimes of the same substance as the belly; but often they are different. When they are different they are called tendons. If this tendon is long, as it is on the muscles which bend the wrist, and hand

and fingers, tney are called cords. The tendons are very strong.

Most of the muscles of the body are designed to move the bones, although some are not; for all the motions of those parts which are not immediately connected with bone are performed by muscles. I shall at this time, however, describe to you those which are designed to move the bones. These have their head in one bone, while their insertion is in another. All those which move the thigh have their head attached to the bones of the pelvis, and those which move the leg are attached to the pelvis or the thigh.

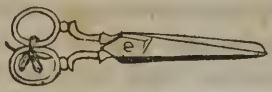
W. How do they act to move the bones?

Dr. B. By contracting or shortening themselves.

W. But how do they do it?

Dr. B. It is difficult to explain it to you; indeed, the precise mode of its operation nobody knows; but I will try to explain to you part of the process.

See, here is a piece of India rubber; I will cut off a thin strip from the edge. You may take the strip and pass it through both rings of these shears, and tie the



ends together so that it will keep them shut.

W. I have.

Dr. B. Now open the shears. That

will do. Let go of one of the rings, and hold the other fast. You see how quick the India rubber made the loose ring move to the fast one, and so shut the shears.

W. Is that the way the muscles act?

Dr. B. The fibres of the muscles can be stretched and can be contracted like the India rubber; and when they do contract, they move the bone in which they are inserted toward that to which their head or origin is attached. This is the way in which the muscles of the lower jaw extend and contract.

W. But the India rubber does not extend and contract by itself; and when it contracts, it does it suddenly. But I can open my mouth, and shut it very quick or very slow, as I choose.

Dr. B. It is very true, and that is one great difference between the *elasticity* of dead matter, like India rubber, and the contractility of living fibre, like muscle. The contraction of the India rubber depends on an independent quality of its substance, while that of the muscles depends chiefly on some law of life; for dead muscle will not extend or contract as it does when alive. I told you that the contractility of the muscle

depends on a law of life no one fully understands. By this law, all the muscles which move our limbs, do so only as we wish. This is one of the mysterious effects of the union of the mind with the body. But we know with certainty what the organs are which communicate the will to the muscles. They are nerves, and I will, by-and-by, describe them to you. But we must now leave our lesson for the present; and, until the next, you may employ your time in reflecting on what you have already learned.

CHAPTER XI.

It was a matter of great wonder to William, how the mind could make the muscles act, merely by willing it; and he could hardly believe it, although, whenever he tried, he found his limbs would move at his will. Still it was a mystery to him. It was not long before he had an opportunity of asking his father for the explanation of this subject. "Do all the muscles depend on the will for their motions?" said he.

Dr. Bell. No; there are several muscles which act without any reference to the will.

William. What are they?

Dr. B. The heart is one, and there are some others. Indeed, there are many muscular fibres, whose contractions do not depend on the will. It would not do at all, to have those muscles by which we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breathe depend on the will. While we were asleep, our breathing would not go on, if they acted only in obedience to the will; and we should die very soon, if, through forgetfulness, our heart should stop beating a few times.

W. But I can breathe, or stop breathing, if I choose, for some time.

Dr. B. You may; but you would hardly be able to stop breathing long enough to die, merely by a direct exercise of your will.

Suppose I should now proceed to what I have to tell you about the muscles of the body. Here is a picture of the muscles in front, as they are situated in the living body. (*Pl. II.*) Those on the right side are as they appear when the skin and fat are removed, and on the left side those which are seen after the first layer of muscles is taken off.

W. How strangely the muscles look!

Dr. B. At No. 1, Plate II, you see a part of the great triangular muscle of the shoulder, called the deltoid muscle. Its

head arises from the collar-bone, and the great projection and part of the ridge of the shoulder-blade. Its belly makes up all that fleshy mass at the upper and outside of the arm bone. It is inserted by its lower angle into the arm bone, about half-way to the elbow. Its use is to pull the arm directly upwards and outwards.

No. 2 is the two-headed muscle of the arm, of which I showed you a picture just now. (See page 113.) The largest head arises from the upper edge of the large cavity of the shoulder joint, and passes over the end of the arm bone at the shoulder joint, and runs a short distance in the groove (*d*) which you see in the arm bone. The short head arises from the short projection of the shoulder-blade, and passes down on the inner part of the arm bone, uniting with the long head, and forming one muscle, which is inserted into the upper and forepart of the spoke bone of the fore-arm. Its use is to bend the fore-arm at the elbow, and assist in turning it.


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The muscles which bend the hand and fingers, are at No. 3. No. 4 are the muscles of the face and neck, and No. 5 are those of the belly.

W. I should like to know the names and uses of all these muscles.

Dr. B. I hope you will, at some time, learn them. It will be necessary before you can be a surgeon. But I shall show you at present only enough to enable you to judge of the shape and general use of those which are most prominent.

No. 7 is a long straight muscle, called the *sartorius*, or tailor's muscle, because it is used in sitting as tailors do. Its use is to cross the legs.

No. 8 exhibits the muscles for moving the leg and foot.

Here is a view of the muscles on the back part of the body. (*Pl. III.*) You see on the right side the muscles as they appear after taking off the skin and fat, and on the other side those that are uncovered by removing the first. No. 1 is the *trapezius*, or four-cornered muscle. No. 2 is the

back part of the *deltoid*, which you saw on Plate II. No. 3 is the large three-headed muscle, for straightening the arm. It is very strong, and is inserted into the end of that remarkable projection of the ulna, which I described to you as forming the elbow joint. It acts with great force, by being inserted into so long a projection. It is often referred to, to show the beautiful manner in which God accomplishes his purposes.

The muscles on the back part of the fore-arm, you see at No. 4. They are used for opening the hand and extending the fingers.

No. 5 is a large muscle called the *gluteus*, and is used to pull the thigh outwards and backwards.

The *hamstring* muscles, or those used to bend the knee, are seen at No. 7.

These are but a few of the muscles of the body, but they are all which I think it best to show you now.

W. Shall you show me those organs

which carry the will of the mind to the muscles, to make them move?

Dr. B. After showing you some other things.

W. Father, my muscles are not as large as your's, and when you were a boy your's were as small as mine. What made your's grow to be so large?

Dr. B. The growth of the body is effected by means of food; but to prepare it for *nourishment* several processes are necessary; and for the purpose of carrying them on, there is a wonderful contrivance and adaptation of organs. Food is first placed in the mouth. It is then chewed, and mixed with the juices of the mouth. Next it is swallowed, and passes into the stomach. There it is mixed with a peculiar fluid, called the gastric liquor, by which it is dissolved, and fitted for the separation of those parts which are nourishing from those which are not. In this state it passes from the stomach into the upper part of the bowels. The nourish-

ing part is there taken up by a great many small vessels, whose mouths open on the inner surface of the bowels. These vessels carry this nourishment, which is called *chyle*, into larger vessels, until they all unite in a large trunk, which is called the *thoracic duct*. From thence it is emptied into a vein, under the left collar-bone, where it mixes with the blood, and becomes part of it. The blood is carried to every part of the body, and nourishes it.

W. This is wonderful! more wonderful than any thing you have told me.

Dr. B. I told you that the blood was carried to every part of the body. I will now show you the system of organs by which the blood is so carried. The centre of this system is the heart; and the branches are the arteries. You have seen the heart of an ox; have you not?

W. Yes, father.

Dr. B. The heart of a man is very much like it, only smaller. It has all the same parts, and has the same offices.


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Here is a picture (*Pl. IV.*) showing the situation of the heart and the principal arteries and veins.

W. Are not the veins and arteries the same?

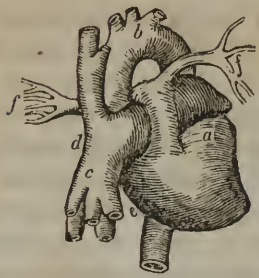
Dr. B. No; I will soon explain to you the difference. The heart, Plate IV, No. 1, is divided into four parts, each of which contains a large cavity for the blood. Two of the parts are called ventricles. These are united together on the outside, so as to seem but one, and constitute the solid part which is usually called the heart. The other two parts are the auricles. Each ventricle has a large artery connected with it, which sends blood to different parts of the body; and each auricle has a vein, which brings the blood back to the heart, after it has been carried out by the arteries. Each artery, and each vein, is more and more divided into branches, as they go farther and farther from the heart. Each auricle communicates to the ventricle with which it is

connected, but the ventricles have a partition between them. So that the two sides of the heart may be considered as two different organs, having each its auricle and its ventricle, communicating with an artery. By means of this apparatus the blood circulates through every part of the frame.

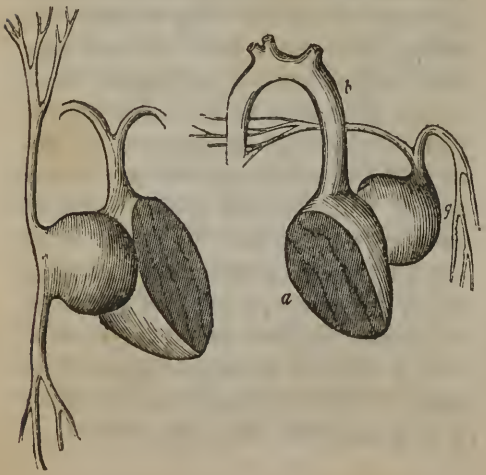
For a great many centuries after the world was created, mankind did not know that the blood moved at all. Its circulation was at length discovered by Dr. William Harvey, in the year 1657. It was a long time before the medical world would believe in this discovery. It is now so well established, however, that the man who should doubt it would only show his ignorance.

W. Can you show me how the blood circulates through the body by means of these organs?

Dr. B. I will endeavour to do it; and for this purpose I will show you, first, a picture of the heart as it appears in the



human body; secondly, as divided in two parts. The heart is described as a hollow



muscle. It might have been with equal propriety described as four hollow muscles; for each ventricle and each auricle acts independently of the other. To show you the mode of the blood's circulation, it is necessary to trace it through its course. We will begin with it at the left ventricle of the heart, (*a*,) in the first cut, and follow it until it returns to the same place again. Here the blood is pure, and fit for all the purposes of life and nutrition. By a powerful contraction of the ventricle, it is thrown with great force into the large artery of the body (*b*) called the aorta. By the contraction of the aorta, together with the repeated contractions of the ventricle, the blood is sent forth into all the smaller branches, and thus furnishes to every part of the body the means of life and growth. What remains is then taken up by the small branches of the veins, and carried by them to the larger veins, until at length it is emptied into a large trunk (*c*) called the *vena cava*, from which it is poured into the right auricle, (*d*.)

From this it goes to the right ventricle, (*e.*) Here it is, by a powerful contraction, thrown into another large artery, (*f,*) called the pulmonary artery, through which it passes in branches to the lungs.

W. I have often heard of the lungs but do not know what they are. Will you tell me now?

Dr. B. They are what are called in animals *the lights*, and are of a spongy structure, filled with very little cells.

W. Are the lights the lungs?

Dr. B. Yes; they are the organs with which we breathe. Every breath fills all the small cavities of the lungs with air.

W. I have often wondered what was the use of breathing. I know men die if they cannot breathe: but how does life depend upon so simple a process as drawing in air and throwing it out again?

Dr. B. The chief object of breathing is to purify the blood. After it has been throughout the system, and returned to the right side of the heart, it is in a very impure state, from many causes. These

I cannot explain to you now. It is enough for you to know, at present, that the blood is impure, and that there is a process for purifying it. The circulation of it through the lungs is this process. In the veins the blood is very dark-coloured, and continues so until it goes to the lungs. In the lungs it is taken up by small veins, and carried to the left auricle, (*g*,) in the second cut. Here it is pure, and of a light-red colour; and in this condition it is carried to the left ventricle, (*a*,) there to commence its circulation through the body as before.

W. How are the arteries made?

Dr. B. They are long tubes, very strong, and composed in part of circular fibres, which enable them to contract, and drive the blood along to their extremities. The veins are tubes likewise, but their action is not so strong as that of the arteries. In them the blood moves slowly and steadily, while in the arteries it moves by successive leaps, corresponding with the contractions of the heart. You per-

ceive this motion when you feel the pulse. Indeed, the pulse is merely the contraction of an artery.

In Plate IV, you see the principal arteries of the body. No. 1 is the heart. No. 2 is the great artery which I pointed out to you, called the aorta, from which all the others proceed, like the branches of a tree. It passes from the upper part of the heart, and immediately turns downward, and runs along the spine. From the place where it turns, (called the arch,) the arteries proceed which furnish the arms, neck, head, &c., with blood. On the right side is one called the nameless artery, (No. 3,) which immediately divides into two, the right carotid and the right subclavian. The left carotid, and the left subclavian, (No. 4,) pass directly from the arch of the aorta, as you see.

Those branches which you see on the face, (No. 5,) proceed from the carotid; and those which you see on the arm, (No. 6,) from the subclavian. A principal branch of the carotid supplies the brain

with blood. It passes through those crooked passages which I showed you on the under side of the skull. And now I can tell you the reason why those passages were made so crooked. The heart drives the blood with great force through the arteries, and the action of the arteries themselves is strong, so as to increase the speed with which it moves. Now, with all this force, if the blood should go straight into the brain, there would be danger of its producing too great pressure on the brain. By the shape and size of these passages, the blood is compelled to move into the brain slower, and of course more safely.

W. How many provisions for our safety and comfort God has made in our construction!

Dr. B. Very true. And how important that we should look into his works, if we would fully appreciate his goodness. The *aorta*, as it passes down, sends off branches to all the adjoining parts. You see in Plate IV, the kidneys, and the arte-

ries leading to them, No. 7. Soon after it passes the kidneys, it divides again into two large branches, which supply the lower limbs. In each limb it divides again. You see it at No. 8. These are but a few of the principal arteries. They divide, as they are spread over the human body, into many thousand branches, and carry the blood to every part, however small. You already know that this blood is returned to the heart by the veins. The numerous branches I cannot describe to you. Nor is it necessary any further than to say, that the veins accompany the arteries, and that wherever you find one you may be sure the other is near by. The large vein, called the *vena cava*, in which they all unite, is seen at No. 9.

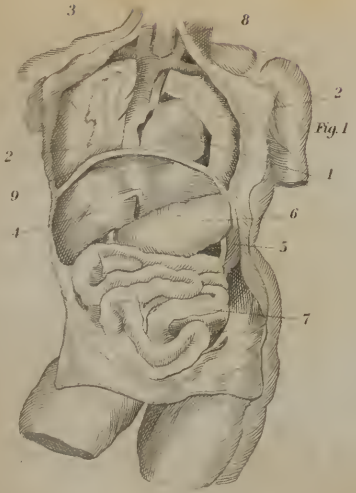
But our time is passing rapidly away, and I can stay no longer. But you have learned enough at this lesson to prove the great truth with which we began, that God is good, and great, and wise, to devise and execute such a fit apparatus for carrying on the different processes of life.

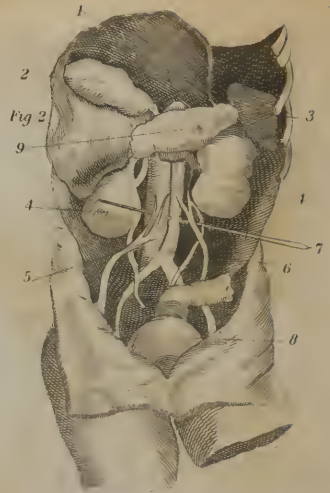
CHAPTER XII.

Dr. Bell. I have spoken to you of the important organs of the chest, and belly, or *abdomen*, and have described the offices of some. Here are two pictures, which show them to you in the situation in which they are placed in the human body. In Fig. 1, No. 1, you see the heart with its natural covering or case. The lungs are at No. 2, and fill the greatest part of the cavity of the chest. I told you their use, when I was describing the circulation of the blood.

William. You did not tell me how the air went in and out in the process of breathing.

Dr. B. I did not; but, as it is not out of place, I will do it now. You know the windpipe, which you see at No. 8, affords a passage for the air from the mouth to the





Pl. 5

lungs. Just before it enters the lungs, it is divided into two branches, and each of these is again divided into a great number of smaller branches, which communicate with every little cell of the lungs. It is through this tube and its branches that the air enters the lungs.

W. What makes the air come into the lungs?

Dr. B. In the first place, all the muscles which are placed between the ribs contract and raise the ribs. This enlarges the cavity of the chest. The air of course flows in to fill it up. There is another mode by which the cavity of the chest is enlarged. If there were not, the mere raising of the ribs would not make room for all the air which is wanted for the purpose of sustaining life.

W. What is it?

Dr. B. You see on Fig. 1, at No. 9, something which looks like an arch. This is a thin muscle, called the diaphragm, attached to all sides of the chest at its lower part, and forming a complete par-

tition between the abdomen and the chest. This muscle is arched upwards very much. When we take in the air, this muscle contracts in every direction, and becomes almost flat, which, you see, increases the cavity of the chest very much; and when the air is breathed out, it expands and leaves the cavity smaller. Besides this, the muscles of the abdomen assist some in increasing and diminishing the cavity of the chest. These are all the organs used in the process of breathing.

I will now point out to you the other parts seen in Fig. 1 and Fig. 2. At No. 3, Fig. 1, you see the *vena cava*, or the great vein, which carries the impure blood from the body back to the heart. There are in the chest, besides these organs and the arteries, the *meat-pipe*, directly behind the *windpipe*. It is called the *gullet*, or *œsophagus*, and by it the food is conveyed to the stomach. The *thoracic duct* passes through the chest.

The contents of the abdomen, exhibited here, Fig. 1, No. 6, are the stomach. I

have told you that the use of the stomach is to receive the food, and prepare it for the separation of that part which is nourishing from that which is not. It passes from hence to the bowels, No. 7, and the nourishment is separated from the useless parts throughout their whole course. Fig. 1, No. 4, is the liver. It is a very large organ, on the right of the stomach.

W. Have you told me its use?

Dr. B. It is to separate or prepare the bile.

W. Of what use is the bile?

Dr. B. It assists in the separation of nourishment from the food. For this purpose it passes from the liver to the gall bladder, which is seen on Fig. 2, at No. 2.

There is an organ which has not been mentioned, a small part of which you see at No. 5, on Fig. 1. It is the *spleen*, and is on the left side of the stomach. It is something like the liver, but smaller. You see nearly the whole of it on Fig. 2, at No. 9.

W. What is its use?

Dr. B. It is not known. Let us look at those parts shown in Fig. 2. No. 4 points out the kidneys, where the urine is formed. No. 6, the aorta. No. 7, a probe under some small blood-vessels. No. 8 is the bladder. This completes all I shall think best at present to tell you of the contents of the abdomen.

We have now come to a part which may be very properly considered the most important part of the body. It is the nervous system, consisting of the brain, the spinal marrow, and the nerves. The brain, you know, is placed in the head, the spinal marrow in the cavity of the spine, and the nerves are scattered over the whole system. The brain is the centre of all feeling and motion in the body, and the organ by which all the operations of the mind are carried on. In this picture (*Pl. VI*, Fig. 1.) you see it as it appears on the side, after removing it from the skull. It presents a very irregular shape and surface, as if the different parts

Fig. 1

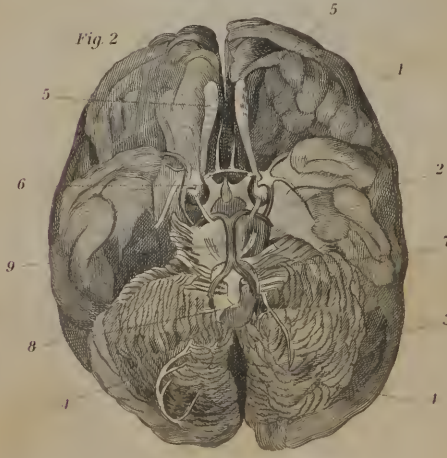


Fig. 2

of its substance, were enveloped in separate membranes, and folded unequally upon each other, forming convolutions of different shapes and sizes. The following are the principal divisions of the brain. The upper part, as seen on Fig. 1, No. 1, called the *cerebrum*. The lower and back part of the brain, (No. 5,) called the *cerebellum*, or little brain. No. 3, a knot, or projection, on the under part of the brain, called the bridge of Varolius. No. 4, the origin of the spinal marrow.—In Fig. 2 you see the brain as it appears when looking upon the base, or under surface. No. 1 is the anterior lobe of the brain. No. 2, the middle lobe. No. 3, the posterior lobe. No. 4, the cerebellum. Nos. 5, show the origin of the *olfactory nerves*, or those of smell, which go to the nose. No. 6, the origin of the *optic nerve*, or the nerve of sight, which goes to the eye. No 7, the *auditory nerve*, or nerve of hearing, which goes to the ear. No. 8, the upper part of the spinal marrow.

No. 9, the bridge of Varolius, upon which are seen the arteries of the brain.

W. Do all the nerves come from the brain?

Dr. B. They have their origin either in the brain, or in the little brain, or in the spinal marrow. These nerves are the instruments which I told you conveyed the will to the muscles. They branch out like cords in every direction, throughout the whole body; and it is by their means that all the functions of life are performed. It is by means of the nerves that we see, hear, taste, smell, and feel. It is by their impulse that every motion of the body is made, and that every organ performs its appropriate office. None of the acts which tend to promote our happiness, or the happiness of others, and none of the functions which assist in supporting life, can be performed without nerves. By means of the nerve of sight you see objects of attraction; by the nerves of motion you obtain them; by the nerves you taste them; and by the

nerves the organs are enabled to act which convert them into sustenance for the body. The brain and nerves are the instruments by which we enjoy, or suffer, from all the objects in the natural, intellectual, or moral world, which come within their reach.

W. I wish you would explain to me more than you have, how we see, and hear, and taste, and smell.

Dr. B. The exact mode in which impressions of external objects are carried to the brain—what it is which receives them in the brain, and returns the dictates of the will to the muscles, are not, and perhaps never will be known in this world. But some of the instruments which effect these objects are pretty well understood. The EYE and the EAR are among the most remarkable of these instruments. These I will briefly describe to you. They are both important organs; and, although neither of them are necessary to life, I need not say we should be deprived of many sources of happiness without them.

Did you ever think how much enjoyment you would lose if you were blind?

W. If I was blind, I should not be able to go anywhere without some one to lead me; and could not run and play with others as I do now. But Joseph Spencer is blind, and he seems to be happy. When his sisters lead him to school, all the boys run to see him, and talk with him, and give him fruit; and if he wants to go anywhere, every-body is ready to help him. I should think he would be very happy. I have never seen him ill-tempered in my life.

Dr. B. Joseph is a good child, and tries, no doubt, to be contented under his misfortune; and all that know him are ready to do any thing to make him happy. But do you not think he would be happier if he could join in the sports of other boys? I watched him the other day, while his schoolfellows were playing ball. He was standing by a bench alone, and listening to their shouts, and the sound of their quick footsteps. Soon he became

too much excited to stand still, and stamped, and clapped his hands, and laughed, and shouted, and opened his poor blind eyes, and reached forth, with an eager wish to join in sport that made others so happy. Suddenly he seemed to feel that it was all in vain; and, though the smile still lingered about his features, the tears that ran down his cheeks betrayed a sad consciousness of his misfortune. Again, the renewed shouts of boisterous mirth renewed his joy, desire, and hope; which were again followed by the same desolate sadness. O! how I wished poor Joseph could see! But he cannot; and his misfortune should teach us how good God is to enable us to see and enjoy the beauties of his creation. I will endeavour now to show you how wisely he has constructed the eye, to accomplish this object.

The eyes, as you know, are placed in those large openings, or sockets, just below the forehead; Plate I, Fig. 5. They are round, or globular, and composed of

several parts. Here are two pictures of the eye. Plate VII, Fig. 2, shows the eye entire, with some of the parts to which it is attached. No. 1 is the outer coat of the eyeball, and is called the sclerotic coat, or the white of the eye. The optic nerve, or nerve of sight, is seen at No. 2. No. 3 points out the muscles that move the eye. No. 4, the artery which, with its branches, furnishes the eye with blood. Fig. 1 represents the eye cut in two parts, from the forward to the back part, and shows its internal structure. No. 1 is the sclerotic coat; No. 2 is the choroid coat; and No. 3 is the retina, or seat of vision. Directly on the forepart of the eyeball is a round transparent substance, called the *cornea*, or glass of the eye, No. 4. It is shaped like the crystal of a watch. Immediately behind this is a coloured, thin, round, muscular veil, like this, with a hole

Fig. 1

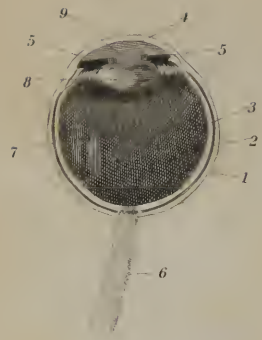
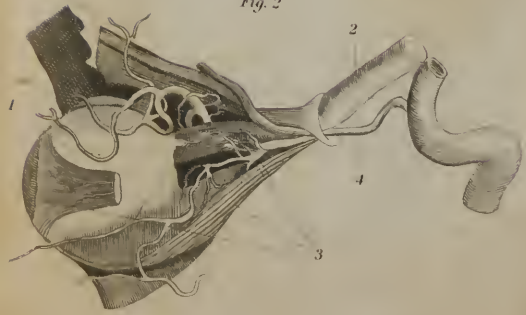


Fig. 2



through the centre. It is called the iris, and the hole the *pupil.* Behind, and very near it, there is a substance, hard and clear. It is shaped like an apricot stone. It is generally compared to a lens or burning-glass; but is thicker in proportion to its size. You will see it at No. 8. This is the *crystalline humour,* or *lens.* Between this and the glass of the eye, there is a clear fluid like water, filling up the whole space, both before and behind the iris. It is called the *aqueous humour.* You see it at No. 9. Behind the lens is the *vitreous humour,* a fluid like the white of an egg. It is marked No. 7. No. 6 is the *optic nerve.* Thus, you see, the simple thing which we call the eye, has a curious and complicated structure. To understand the design of this structure, and to see how perfectly it is calculated to accomplish the object for which it was made, we must learn what that is which we call sight.

W. Do explain this to me, I have

often wondered what there was in my eyes that made me see.

Dr. B. I will endeavour to explain it; but you must be very attentive, or you will not understand. Besides all this apparatus of the eye, it is necessary that there should be light, or we could not see.

W. I know we cannot see without light. But how do we see with it? What is light?

Dr. B. Nobody knows exactly what light is; but some of its properties are understood.

W. What makes light?

Dr. B. The sun and fixed stars are chief sources of light.

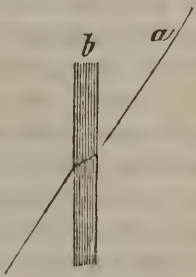
W. Is not the moon a source of light?

Dr. B. The moon reflects the sun's light upon the earth. We have some other sources of light, such as fire, rotten wood, fireflies, glowworms, &c. There is some difference between these different kinds of light; but they are so nearly alike with respect to sight, that in explaining them I shall only speak of the light

of the sun. This, when it comes directly upon the eye, is very bright and dazzling. There are some things through which the light passes, as air, water, glass, &c. You know the sun will shine through each of these. There are some through which it will not pass, as slate, iron, wood, &c. If you hold either of these between your eyes and the sun, you cannot see it. Those things the light does not pass through are called *opaque;* and those through which it does pass are called *transparent.* There are substances through which *some* light passes, but which we cannot *see* through; as paper, thin ivory or bone, and ground glass. These are called *translucent.* Any body through which light passes is called its *medium.* In passing through any medium, light moves in straight lines. If you prick a small hole through a thick paper, and fix it to a window, so as to shut out all the light but what passes from the sun through the small hole, that will go in a straight line. The straight lines of light

are called *rays;* and unless the medium is changed, they continue to move in straight lines. But if they pass in a slanting direction from a rare to a dense medium, as from air to water, or from water to air, the direction of the ray is changed.

Here is represented a ray of light (*a*)



passing through the air till it comes to a thick piece of glass, (*b.*) As it passes through the glass, you observe, the direction of it is changed; and when it passes from the glass into the air again, it is again changed.

W. Then water is denser than air, and air is rarer than water, is it not? Why do you not say thicker and thinner?

Dr. B. Because thick and thin are used in different senses. Sometimes they refer to size, when we say a thick board, and a thin shingle. Sometimes to consistence, as thin gruel and thick syrup. In one sense, the air is thicker than water, and in another it is thinner. The words *denser* and *rarer* are therefore better.

W. I see they are; and now I understand what you mean by a denser medium. What becomes of the light which falls upon *opaque* bodies, as it does not pass through them?

Dr. B. It is chiefly *reflected* from them; and it is by this means that we see objects.

W. I do not quite understand how the rays of light change their direction by passing from one medium to another.

Dr. B. I do not know that I can make you understand it any better; but I will show you an experiment by which you

may, perhaps. Here is an empty basin. Let us put a bright cent in the bottom of it. Set the basin on the table. Do you see the cent?

W. I do.

Dr. B. Well, it is because the rays of light are reflected to your eyes from the cent. Now walk away until you just see the further edge of the cent.

W. I can but just see it now.

Dr. B. Now move a trifle further, so that the edge of the basin will just hide the cent. That will do. Look at the basin, and do not move, and I will fill it

with water. I shall pour it in carefully, so as not to move the cent.

W. O! you have moved it, for I can

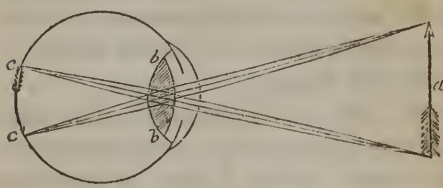
see the whole of it, and I have not moved in the least.

Dr. B. No, you have not moved, nor has the cent moved. But the rays of light, as they come to your eye from the cent, have changed their direction, by passing through water instead of air. The picture shows you by the line *a*, how the rays moved when there was no water in the basin; and the line marked *b* shows how the rays moved when the basin was filled with water.

W. This is very singular; but what has that to do with my seeing things out of water? When I look at that tree yonder, I do not look through water. What is it that makes me see that tree?

Dr. B. You could not see it, if it were not for the light reflected from the leaves, and branches, and trunk. But light is reflected from it; and when you look at it, some rays come to your eye from every part of its surface, in straight lines. For light moves in straight lines, whether it

comes directly from its source, or is reflected from other objects. The rays from that tree, as they come to your eye, may be represented thus. By the round form of the glass of the eye, more rays strike upon it from the tree, than would if it was flat. This is the first step in the process of sight. Take this figure for



example. The rays of light which pass from the head or point of the arrow, (*a*,) separate, or diverge, until they pass through the crystalline humour, or lens, (*b b*,) where they cross. Then they converge, or approach each other, and form a little inverted image of the arrow on the retina, at *c c*. You see, by this arrangement, first, that very many rays are brought from the object upon which we look, to

the glass of the eye ; second, that by the glass of the eye, and the humours, their direction is so much changed as to be spread in a small space upon the retina, and that a small bright image is formed there: and, thirdly, that the impression of this image is carried to the brain by the optic nerve. This is the process of sight.

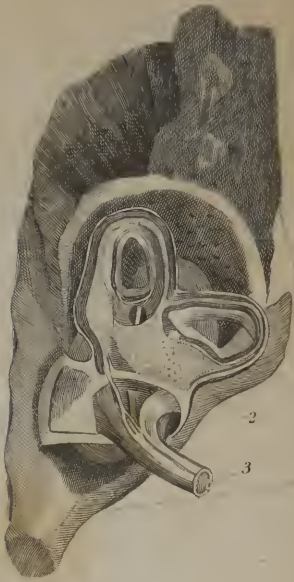
W. And it is so wonderful, that I cannot see how any one who understands it, can believe the eye was made by chance. Is the construction of the ear as wonderful as that of the eye?

Dr. B. It is more complicated, and as wonderful; for it answers the purpose as well for which it was made. But the exact design of its several parts is not as well understood. Here is a picture of the ear, showing the whole apparatus of hearing, from the outside to the brain. (See next page.) The external ear (*a*) is broad and hollow, and admirably contrived to collect sounds; and the external

tube (*b*) is as well calculated to convey the sounds to the internal parts.

W. What is sound?

Dr. B. Sounds are of different kinds, from the feeblest humming of the little insect, to the loudest thunder. Their sources are therefore various. They are all produced, however, by a certain motion of the air, which is carried by the organs of hearing to the brain. At the bottom of the *external tube* (*b*) is the *tympanum*, (*c*,) or *drum of the ear.* It is a membrane stretched across the open-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ing which you saw in the skull. Do you perceive some bones (*d*) just behind this membrane?

W. I see something which may be bones.

Dr. B. There are four bones there, and one of them is connected with the *drum*, and they are all connected together, forming a chain which extends to *e*, another membrane stretched across another opening. This membrane may be called the *inner drum*. The opening to which this is attached, is the entrance to a very singular cavity, called the *labyrinth* of the ear. You see a part of it at No. 2, Plate VIII. This labyrinth consists of several tubes, irregularly arranged, filled with a watery fluid, and lined with a thin membrane, upon which are spread out the branches of the nerve of hearing.

In this picture, (*Pl. VIII.*) you see some of the internal parts of the ear, as they would appear from the inside of the skull, if a part of the bone was cut

away. No. 1 is a part of the inside of the skull. No. 2 is a part of the cavity of the labyrinth; and No. 3 is the *auditory nerve*, or nerve of hearing.

And now you have seen all the parts necessary to understand the process of hearing. The concussions of the air producing sound are collected by the external ear, and conveyed by a tube to the drum. They produce a motion upon the drum of the ear, which is carried by the small bones to the *internal drum*. This creates a motion of the fluid in the labyrinth, by which an impression is made upon the membrane which lines this cavity, and this impression is carried by the nerve of hearing to the brain.

W. Do you suppose, father, that anybody who understands the structure of the ear believes that it came to be so of itself, without being made so?

Dr. B. There are some who pretend they think so. And we may all, by great efforts, make ourselves believe almost any

absurdity, if we choose; but such belief is wicked, and not the result of honest inquiry.

I have now described to you, in part, the system of bones; the system of muscles; the system of organs which more especially assist in the nourishment and growth of the body; the system of nerves; and, at last, two very important organs of sense, all accompanying and connected with each other. Each part of all is wonderful, and calculated to convince every one who will examine it, of the EXISTENCE, POWER, WISDOM, AND GOODNESS OF GOD. But when we come to view them connected together, and each dependent on the other for existence, and so wonderfully adapted in all their parts to sustain that existence; and when we see that existence attended with such means of enjoying what God has given us, and of giving enjoyment to others; and, especially, when we see how fit a tenement the body is for the soul, and

how well it is designed to aid it in its great responsibilities, and to fulfil its high destinies; with what deep emotions of wonder, praise, gratitude and love, should we acknowledge the greatness, the wisdom, and the goodness of our Creator!

THE END.